

A provisional classification of Australian terrestrial geoplanid flatworms (Tricladida: Terricola: Geoplanidae)

By L. Winsor*

Abstract

A provisional classification of Australian geoplanid terrestrial flatworms is provided, and is placed in context with earlier and current studies. The genus *Caenoplana* is emended, and the heterogeneous genus *Artioposthia* divided into five groups. Diagnoses are provided for six new genera: *Australoplana* gen. nov.; *Parakontikia* gen. nov.; *Reomkago* gen. nov.; *Fletchamia* gen. nov.; *Lenkunya* gen. nov. and *Tasmanoplana* gen. nov.

Introduction

Terrestrial flatworms (or land planarians as they are also known) are entirely free-living carnivorous members of the phylum Plathelminthes. Normally nocturnal in habit, they frequent dark, humid, but generally not wet microhabitats beneath fallen rotting logs and leaf litter. They occur in a variety of habitats ranging from tropical rainforest to arid semi-desert.

The first record of these flatworms in Australia was made by Charles Darwin during the *Beagle* voyage in 1836 who collected specimens of one species from Hobart, Tasmania. Interest in the group increased with the majority of species in Australia being described between 1888 and 1901. The Terricola worldwide were monographed by Graff (1899), the preparations for which undoubtedly provided impetus for much of the research on the group undertaken in the colony. Apart from Wood (1926) and Fyfe in New Zealand (1956) there was little scientific interest expressed in the Australian terrestrial flatworms until the 1970s. The Australian terrestrial flatworm fauna presently comprises over 82 species and seven varieties belonging to two principal

families, the Rhynchodemidae and the Geoplanidae.

There are a number of problems which confront the modern taxonomist working on Terricola. Many early species descriptions were published in obscure journals and are thus difficult to obtain and correlate, if indeed workers are aware of them. Type specimens are often in European or other overseas museums and are difficult to trace and obtain. Early species descriptions rest almost entirely upon external morphology. Modern taxonomy of the Terricola is based upon a combination of external morphology, and internal anatomy revealed by histological investigations. As terrestrial flatworms can exhibit considerable external morphological intra-specific variation and inter-specific similarities it is essential that type specimens are histologically examined and that these form the basis of modern descriptions and classifications.

The immense task of indexing the Terricola of the World is currently being undertaken by R.E. Ogren and M. Kawakatsu (1987, 1988, 1989, 1990). However in the forthcoming "Index to the species of the family Geoplanidae - Part II", modern taxonomic treatment of Australasian taxa is hampered as published anatomical descriptions are only available for some 12% of described species. This has already unfortunately resulted in problems in the genus *Caenoplana*, reinstated without reference to the type specimens by Ogren & Kawakatsu (1988a,b). When histologically examined, the types of species in the genus were found to represent two genera (Winsor, 1991).

Both type and other specimens of a large portion of Australian taxa have been examined by the author within the context of taxonomic revisionary studies on the terrestrial flatworms. Unfortunately this work is still some way from completion

*Department of Zoology, James Cook University of North Queensland, Townsville, Qld 4811.

and publication. It is therefore appropriate that a provisional classification of the Australian Terricola is provided now. This synopsis should assist in the higher classification of Australian taxa to be listed in the forthcoming "Index to the species of the family Geoplanidae - Part II" (Ogren & Kawakatsu, MS in press).

The purpose of this paper is to (1) re-define the genus *Caenoplana* and erect a new genus to accommodate the resulting excluded species as foreshadowed (Winsor, 1991) and (2) provide a provisional classification of the Australian geoplanid Terricola (and where appropriate, New Zealand taxa).

Explanatory notes

The types examined are held by State and overseas museums. Additional material was obtained from the author's collection. Histological methods employed have been indicated elsewhere (Winsor, 1983). Terminology for dorsal regions follows Graff (1899) and for anatomical structures Cannon (1986). The cutaneous muscular index (CMI) is the thickness of cutaneous musculature relative to the body height (the mc:h index of Froehlich (1955). The parenchymal musculature index (PMI) (Winsor, 1983) is similarly calculated from the sum of the heights of the dorsal and ventral ring zone, or the ventral muscular plate, whichever is present. In the genus *Artioposthia* accessory auxiliary organs are termed adenodactyls (finger like glandular organs that project into the genital atria), adenchiren (comb-like organs in which the multiple adenodactyls are embedded in muscular flaps) and adenomuralia, a new term coined here (Greek - aden, a gland + Latin - muralis, of walls) to describe glandulo-muscular organs that are embedded in the walls of the copulatory organs.

Generic diagnoses

Genus *Caenoplana* Moseley, 1877

The original definition: Body long and wormlike, much rounded on the back,

flattened on the under surface, without an ambulacral line. External longitudinal muscular bundles largely and evenly developed over both dorsal and ventral regions. Lateral organs distinct and isolated as in *Rhynchodemus*, and, as in it, connected by a transverse commissure. Eyes absent from the front of the anterior extremity and scattered sparsely on the lateral margins of the body for its entire extent. Mouth nearly central, pharynx cylindrical.

Emended: Geoplanidae of elongate body form, cylindrical to sub-cylindrical; mouth situated just posterior of mid venter; gonopore closer to mouth than to posterior end; creeping sole 60% or more of body width; eyes mostly small in a single row around the anterior tip, crowded antero-laterally in an irregular cluster, and extending posteriorly in a staggered submarginal row; cutaneous circular and paired diagonal muscle layers are mostly poorly differentiated, presenting as a circulo-oblique layer; cutaneous longitudinal muscles very weak and equally developed dorsally and ventrally; CMI ranges from 1.6 - 4.5%; parenchymal longitudinal muscles present as single fibres or as small isolated bundles embedded within circulo-oblique muscle fibres arranged in a distinct ring zone, PMI (for ring zone) 20 - 28.5%; anterior glandulo-muscular organs and sensory papillae absent; cylindrical pharynx; testes and sperm ducts ventral; penis of the eversible type, without papilla; vagina enters ventrally or horizontally; ovovitelline duct enters vagina ventrally; copulatory organs without adenodactyls or adenomuralia.

Localities: principally in south-eastern Australia and New Zealand, with species introduced into urbanized areas of the United States of America, New Zealand and the United Kingdom.

Type species: *Caenoplana coerulea* Moseley, 1877; designated by Ogren & Kawakatsu, 1988a.

Note: Two groups are recognized here.

The *coerulea* group: *C. coerulea* Moseley, 1877; *C. spenceri* (Dendy, 1890); *C. walhallae* (Dendy, 1891); *C. dendyi* (Spencer, 1891), characterized by the presence of blue-green pigmented rhabdoids; inner and outer and pharyngeal musculature comprised of longitudinal muscles underlain by circular fibres, internal to which is a layer of interwoven longitudinal and circular muscle fibres; musculature of the copulatory organs comprises interwoven longitudinal and circular fibres. Cutaneous circular and diagonal musculature of *C. dendyi* are well differentiated.

The *subviridis* group: *C. sub-viridis* Moseley, 1877; *C. variegata* (Fletcher & Hamilton, 1888); *C. sulphurea* (Fletcher & Hamilton, 1888); *C. hoggii* (Dendy, 1891); *C. bicolor* (Graff, 1899); *C. dubia* (Dendy, 1892a); *C. citrina* (Wood, 1926); *C. barringtonensis* (Wood, 1926). Most of the members of this group are yellow or brown in colour with green or dark brown longitudinal stripes. The musculature of the body wall, pharynx and copulatory organs of species within this group exhibit greater differentiation than those of the *coerulea* group.

The following species are provisionally placed within *Caenoplana*: *G. viridis* (Fletcher & Hamilton, 1888); *C. hillii* (Steel, 1897); *C. ponderosa* (Steel, 1897); *C. albolineata* (Steel, 1987) and *Geoplana daemeli* (Graff, 1899), in part. Two New Zealand species, *G. purpurea* (Dendy, 1895b); *G. tenuis* (Dendy, 18985b) are also assigned to the genus.

Genus: *Australoplana* gen. nov.

Body elongate, strap-like; broadly convex dorsally, flat ventrally; mouth situated in posterior third of body; gonopore closer to mouth than to posterior end; creeping sole less than 25% of body width; eyeless, or with a single row of minute eyes around the anterior tip and laterally to the posterior tip; cutaneous

musculature comprised of circular, diagonal and longitudinal muscle layers, with the longitudinal muscles equally developed dorsally and ventrally; CMI ranges from 10 – 16%; parenchymal longitudinal muscles very weak or absent; anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical or bell-form (glockenförmig); testes and sperm ducts ventral; ventro-posterior diverticulum may be present in copulatory organs; intra-antral papilla present in penis of some species; vagina enters horizontally; ovovitelline ducts open ventrally into vagina; adenodactyls and adenomuralia absent.

Localities principally in eastern Australia and New Zealand. Two or three species have been introduced into New Zealand and Great Britain.

Type species: *Caenoplana sanguinea* Moseley, 1877, here designated.

The generic epithet is derived from *austral* (Latin – southern), and *plana* (Greek – roaming; a wanderer) often used in the names of flatworms.

Note: Three groups are recognized here. The first two are Australian, the third a New Zealand group (species of which have been introduced into Great Britain).

The *sanguinea* group: *A. sanguinea* (Moseley, 1877); *A. rubicunda* (Fletcher & Hamilton, 1888); *A. alba* (Dendy, 1891); *A. alba* var. *roseolineata* (Dendy, 1892a). *A. minor* (Dendy, 1829b) may also be referred to this group. All species in this group have eyes, and a cylindrical pharynx. An intra-antral penis papilla is present in the first three species.

The *typhlops* group: *A. typhlops* (Dendy, 1984); together with undescribed species. All are eyeless, with bell-form pharynx. A ventro-posterior diverticulum is present only in *A. typhlops*.

The New Zealand group: *A. sanguinea* var. *alba* (Jones, 1981); and undescribed species. They are characterized by the presence of small bundles of ventro-lateral parenchymal muscles, and bell-form pharynx.

Genus *Parakontikia* gen. nov.

Body elongate, cylindrical to subcylindrical; mouth situated just posterior to mid venter; gonopore closer to mouth than to the posterior end; creeping sole ranges, from 54–84% body width; eyes generally large, in a single row around the anterior tip and in a submarginal row posteriorly without antero-lateral crowding; cutaneous musculature comprised of circular, diagonal and longitudinal muscles, the latter layer strong and generally equally developed bundles dorsally and ventrally; CMI ranges from 6.7–13.1%; parenchymal longitudinal muscles present in a ventral plate or ring-zone; PMI for ring zone or plate ranges from 5.5–13.8%; anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical; testes and sperm ducts ventral; penis of the eversible type without a papilla; vagina enters horizontally; ovovitelline ducts open ventrally into vagina; adenodactyls and adenomuralia absent.

Localities: eastern and Western Australia; Papua-New Guinea.

Type species: *Geoplana ventrolineata* Dendy, 1892a, here designated.

Etymology: The generic epithet alludes to the similarities between this genus (*para*, Greek – beside) and the Indo-Pacific genus *Kontikia*.

The genus includes *P. ventrolineata* (Dendy, 1892a); *P. atrata* (Steel, 1887); *P. coxii* (Fletcher & Hamilton, 1888); *P. melanochoea* (Steel, 1901a) and *P. lyra* (Steel, 1901b). In the Papua-New Guinea species *P. chapmani* (Ogren & Kawakatsu, 1988b) there are only 16 eyes present around the anterior tip and for a short distance laterally. However other characters accord with this genus to which the species is transferred.

Genus: *Reomkago* gen. nov.

Body elongate, quadrangular in cross section with rounded corners; dorsal and ventral surfaces flat; lateral surfaces inwards sloping; mouth posterior of mid-

venter; gonopore half way between mouth and posterior end; creeping sole less than 50% of body width; small eyes in a single row around the anterior tip and in a staggered sub-marginal row posteriorly without anterolateral crowding; cutaneous musculature strong, comprising circular, diagonal and longitudinal muscles; with greater development of the longitudinal muscle layer ventrally than dorsally; CMI 18%; longitudinal parenchymal musculature weak, generally confined to a ventral plate; PMI 8.5%; very strong laterally situated dorso-ventral muscles (largely responsible for the quadrangulate shape); anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical; testes and sperm ducts ventral; copulatory organs complex; with penis papilla; prostatic region anterior of penis bulb; ducts rise dorsally before entering penis bulb horizontally; vagina enters horizontally; ovovitelline duct enters vagina ventrally; adenodactyls and adenomuralia absent.

Localities: eastern Australia (mainland and Tasmania)

Type species: *Geoplana quadrangulata* Dendy, 1891, *hirc* designated.

Etymology: The generic epithet is a combination of the initials of R. E. Ogren and M. Kawakatsu with the suffix *-ago*, from the Greek *ago* – to lead, guide, stimulate, promote. The gender is masculine. It honours the industry and magnificent achievement of these two compilers in indexing the species of the Terricola, thus greatly facilitating future taxonomic studies.

Note: the genus includes *R. quadrangulatus* (Dendy, 1891); *R. ventropunctatus* (Dendy, 1892d); *R. wellingtoni* (Dendy, 1892d) and *R. flynni* (Dendy, 1915). These agile species have a pale ground colour with distinctive brown mottling.

Genus: *Fletchaniia* gen. nov.

Body elongate, sub-cylindrical; mouth approximately central; gonopore generally nearer mouth than the posterior end;

creeping sole ranges from 50–70% body width; eyes equally large and small, in a single row around the anterior tip, crowded antero-laterally, then continued posteriorly in two to three staggered submarginal rows; antero-lateral eye patch lens-shaped extends to the lateral region of the dorsal surface; cutaneous musculature weak, with circular, diagonal and longitudinal muscles, the latter in bundles; CMI ranges from 2.3–6.2%; parenchymal musculature weak, comprised chiefly of a loose ring zone of circulo-oblique fibres; parenchymal longitudinal muscles present as isolated fibres largely confined to a weak ventral plate; PMI for plate ranges from 2.3–4.3%; anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical; testes and sperm ducts ventral; copulatory organs complex; prostatic region anterior to penis bulb; ducts enter prostatic region dorsally; penis of eversible type; rudimentary intra-antral papilla present in penis of some species; female atrium elongate, the posterior end communicating with a diverticulum; vagina horizontal, enters floor of atrium anterior to the diverticulum; ovovitelline ducts enter vagina ventrally or horizontally; adenodactyls and adenomuralia absent.

Localities: eastern and Western Australia; possibly introduced into New Zealand.

Type species: *Geoplana quinquelineata* Fletcher & Hamilton, 1888, here designated.

Etymology: The generic epithet is derived from the surnames of J.J. Fletcher and A.G. Hamilton. It commemorates the valuable contributions of these two colonial naturalists to our knowledge of the native terrestrial flatworms.

Notes: Included in this genus are *F. quinquelineata* (Fletcher & Hamilton, 1888); *F. m'mahoni* (Dendy, 1891); *F. sugdeni* (Dendy, 1891); *F. mediolineata* (Dendy, 1891); *F. quinquelineata* var *accentuata* (Steel, 1897) and *Fletchamia* sp. (Winsor, 1977). The species *F. fusco-*

dorsalis (Steel, 1901a); *F. mediolineata* var *simularis* (Steel, 1901a); *F. dakini* (Dendy, 1915) and *F. flavilineata* (Dendy, 1915) may also be referred to the genus.

Genus: *Lenkunya* gen. nov.

Robust body, broadly convex dorsally, flat ventrally; mouth central; gonopore closer to the mouth than to the posterior end; creeping sole ranges from 70–80%; eyes in a single row around the anterior tip, crowd antero-laterally, then continue posteriorly in a staggered submarginal row to the level of the pharynx; very sparse thereafter; antero-lateral eye patch lens-shaped and extends to the lateral region of the dorsal surface; cutaneous musculature weak, with circular, diagonal and longitudinal muscles, the latter in small bundles; CMI ranges from 3.6–5.5%; parenchymal longitudinal muscles strong, present as isolated fibres in a ring zone of circular and diagonal muscles; PMI ranges from 12–28%; anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical; testes and sperm ducts ventral; copulatory organs simple with well developed penis papilla, vagina enters horizontally; ovovitelline duct approaches ventrally; adenodactyls and adenomuralia absent.

Localities: south eastern and Western Australia.

Type species: *Geoplana munda* Fletcher & Hamilton, 1888, here designated.

Etymology: The generic epithet is an aboriginal word meaning beautiful. The dialect and language group are unknown. The species in this genus are most attractively marked.

Notes: In the genus are included: *L. munda* (Fletcher & Hamilton, 1888); *L. adae* (Dendy, 1891); *L. frosti* (Spencer, 1891); *L. adae* var *extralineata* (Dendy, 1892c) and *L. adae* var *fusca* (Dendy, 1894). The species *L. ornata* (Fletcher & Hamilton, 1888); *L. virgata* (Fletcher & Hamilton, 1888) and *L. arenicola* (Steel, 1901a) may also be referred to the genus.

Genus: *Tasmanoplana* gen. nov.

Body elongate, sub-cylindrical, flat ventrally; mouth just posterior of mid venter; gonopore nearer to mouth than to posterior end; creeping sole over two thirds of body width; eyes small, in a single row around the anterior tip extending posteriorly in a single staggered sub-marginal row without antero-lateral crowding; cutaneous musculature strong with circular, diagonal and longitudinal muscles, the latter in bundles; CMI 6.6–9.7%; parenchymal musculature mainly comprised of very strong, compact longitudinal muscle fibres in a ring zone; PMI 11.5–20%; anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical; testes and sperm ducts ventral; copulatory organs simple with small penis papilla; vagina enters horizontally; ovovitelline duct enters vagina ventrally; ventro-posterior diverticulum present ventral to the female atrium, opening into copulatory canal; adenodactyls and adenomuralia absent.

Localities: south eastern and south western Australia.

Type species: *Planaria tasmaniana* Darwin, 1844, here designated.

Etymology: The generic epithet alludes to the first record of terrestrial flatworms in Australia. Charles Darwin collected the type species during the visit of H.M.S. Beagle to Hobart, Tasmania, 2nd–17th February, 1836.

Notes: The genus includes: *T. tasmaniana* (Darwin, 1844) and *T. tasmaniana* var *flavicincta* (Steel, 1901b). The species *T. balfouri* (Graff, 1899) and *T. comitatis* (Dendy, 1915) may also be referred to the genus.

Genus: *Artioposthia* Graff, 1896

Original definition (translated from German): Geoplanidae without creeping ridge and glandular margin, of elongate form, with body apertures on the ventral surface, and with at least a pair of accessory auxiliary organs in addition to the male copulatory organ.

Emended: testes and sperm ducts ventral

Graff assigned six species to the genus. Since then numerous species, chiefly New Zealand taxa investigated by Marion Fyfe during the period 1937–1956, have been included in the genus on the basis of the presence of accessory auxiliary organs in the copulatory organs. Unfortunately the majority of descriptions are incomplete and lack details of body musculature.

Full anatomical studies on several species of *Artioposthia* undertaken by the author reveal that the genus is heterogeneous. At least five groups, at this stage chiefly based upon musculature, can be recognized. All have ventral testes and sperm ducts, and most taxa have a penis papilla.

Formal re-definition and restriction of *Artioposthia*, and subsequent allocation of excluded species into new genera should only be undertaken following examination of type material. At present few relevant type specimens of Australian taxa have been examined. Sectioned type specimens of New Zealand taxa need to be augmented by new material.

The following groups are present within *Artioposthia*. As these data, including that provided by Graff, 1899, have mostly been derived from non-type specimens, the assignment of species of these groups must be regarded as provisional.

Artioposthia Group 1.

Body elongate, broad, convex dorsally, flat ventrally; with weak cutaneous longitudinal muscles in bundles, evenly developed dorsally and ventrally. Parenchymal longitudinal muscles weak, comprised of isolated fibres arranged in a very loose ring zone.

Included in this group: *A. fletcheri* (Dendy, 1891) (this species was the first species assigned to the genus); *A. fletcheri* var *borealis* (Dendy, 1895a).

Artioposthia Group 2.

Body elongate, broad, convex dorsally, flat ventrally; with weak cutaneous

longitudinal muscles, equally developed dorsally and ventrally. Parenchymal longitudinal muscles strong, not firmly united in bundles but exhibiting grouping of fibres, present in a ring zone.

Included in this group: *A. lucasi* (Dendy, 1891); *A. adelaidensis* (Dendy, 1893) and *A. diemenensis* (Dendy, 1894). The species *A. mortoni* (Dendy, 1894); *A. grubei* (Graff, 1899); *A. nicholksi* (Dendy, 1915) and the Adelaide specimens of *Caenoplanus daemeli* (Graff, 1899) may also be referred to this group.

Artioposthia Group 3.

Body small, elongate, sub-cylindrical; with strong cutaneous longitudinal musculature, equally developed dorsally and ventrally; parenchymal longitudinal muscles in ring zone or ventral plate.

Included in this group: *A. alfordensis* (Dendy, 1896), a New Zealand species.

Artioposthia Group 4.

Body small, elongate, cylindrical to sub-cylindrical; cutaneous longitudinal muscles weak, more developed ventrally than dorsally; parenchymal musculature weak, largely confined to a ventral plate.

Included in this group: *A. grammicola* (Steel, 1901a) and *Artioposthia* sp. (Winsor, 1979), both Australian species, and *A. polyadoides* (Fyfe, 1956), a New Zealand species.

Artioposthia Group 5.

Body robust, elongate; convex dorsally, slightly concave ventrally; with strong cutaneous longitudinal muscles, the ventral muscles slightly more developed than those dorsally; parenchymal longitudinal muscles very weak or absent.

Included in this group: *A. howitti* (Dendy, 1892c); *A. howitti* var *obsoleta* (Dendy, 1892c) and *A. robusta* (Steel, 1897). *A. regina* (Dendy, 1892b); *A. parva* (Steel, 1897); *A. warragulensis* (Graff, 1899); *A. scaphoidea* (Steel, 1901a); *A. dovei* (Steel, 1901b). *A. harrisoni* Wood, 1926 may also be referred to this group.

Localities: *Artioposthia* species have been described from the Philippines, Australia and New Zealand. One species has been introduced into Great Britain from New Zealand.

Acknowledgments

A considerable portion of the author's collection of terricola used in part as a basis for this work, was obtained with the willing help of members of the F.N.C.V. Field Survey Group to whom I am most grateful. Dr Lester Cannon, Queensland Museum, kindly read the manuscript and his advice and support are deeply appreciated. Support for these taxonomic studies by the C.S.I.R.O. Science and Industry Endowment Fund and the Australian Biological Resources Study is gratefully acknowledged.

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